DRAFT 01/08

Puget Sound Nutrient Modeling Strategy

Management Questions:

Year 1-2: Are nitrogen loadings from point sources in and around Puget Sound, particularly sewage treatment plants, sufficient to warrant installation of advanced nitrogen removal for all plants in the Puget Sound basin?

Year 3-10: What are current human impacts to biomass and dissolved oxygen levels in sensitive embayments around the Sound, and what improvements are necessary to reduce or eliminate those impacts?

Outcomes

1) Provides scientific basis for Ecology decision to pursue (or not pursue) new AKART requirements for nitrogen control in Puget Sound basin
2) Provides scientific basis for site-specific TMDLs and water quality based NPDES permits to protect sensitive embayments against of nitrogen impacts.
3) Develops the first high resolution hydrodynamic and water quality model of the entire Puget Sound, which will be useful for analysis of other Puget Sound concerns, including near-short restoration, bacteria, toxics, and spill response.

Action Agencies under the Clean Water Act: Ecology, Tribes, EPA

Project Management Lead: Ecology

Organizations Currently Developing Nutrient Models in Puget Sound: Ecology, PNNL, UW

Multi-Agency Organization for Coordination of Modeling Activities in Puget Sound: PSMEM-C

Proposed Analysis Strategy

The following table summarizes the tasks to be completed to answer the management questions and achieve the outcomes described above.

Level of Detail and Schedule	Marine Model	Terrestrial/River Loadings	Point Source Characterization	Technical Issues Resolved	Management Decision Supported	Estimated Project Cost ($)
1 6 mo.	WASP Box Model of Entire Sound	Mining of existing USGS and Ecology database information	Extrapolate from existing South Sound estimates	Provides boundary conditions, initial conditions, and parameter estimates for level 2 model	Preliminary information on large scale influence of human impacts on water quality	Model – 50K Data Compilation – 50K Total 100K
2 1 year	FVCOM (or equivalent) Coarse Grid Model of Entire Sound	Broaden multiple linear regression (MLR) used in South Sound Apply SPARROW framework used in Long Island Sound and Mississippi River assessments	Broaden voluntary South Sound sampling effort to all major point sources	First model of entire Sound suitable for management decisions Provides boundary conditions, initial conditions, and parameter estimates for level 3 model	Necessity for basin-wide nutrient controls for point sources, particularly sewage treatment plants	Coarse grid model - 200K Terristrial/River - 100K Pt Sources - 100K Total 400K
3 Ongoing	Models for Bays currently under development, including: Budd Inlet South Sound Hood Canal	Detailed monitoring of local tributaries	Detailed monitoring of all local point sources	Assessment of potential nutrient problems in a subset of sensitive embayments	Necessity for watershed-specific nutrient controls, particularly sewage treatment	Fully Funded – In Process

Level of Detail and Schedule	Marine Model	Terrestrial/River Loadings	Point Source Characterization	Technical Issues Resolved	Management Decision Supported	Estimated Project Cost ($)
3 2+ years	FVCOM (or equivalent) Fine Grid Model for Future Embayment Studies, including these "new basins": Whidbey Dyes/Sinclair Corroboration of previous embayment studies Confirmation of level 2 findings for basin-wide nitrogen impacts	Detailed monitoring of local tributaries – new basins only Detailed watershed modeling by basin[1], beginning with a pilot study before launching a larger effort.	Detailed monitoring of all local point sources – new basins only	Provides "full service", high resolution water quality model of entire Sound	Necessity for watershed-specific nutrient controls, particularly sewage treatment Confirmation of earlier decisions "One stop shop" for many issues other than nutrients, including: near shore restoration effects, toxics assessment, spill tracking prediction, tidal energy analysis, Canada/USA impact comparisons, and fish tracking	Fine grid model – Initial corroboration testing against previous areas studied (e.g, South Sound) – 300K New basins – 500K to 1 Million per basin for refined monitoring and marine modeling, depending on level of detail Terristrial/River – 200 to 800K per basin for refined monitoring, depending on level of detail Pt Sources – 50 to 100K per basin for refined monitoring Totals Working fine grid model – 300K Specific Basins - 750K to 1.9 Million per basin, depending on level of detail and data collection effort

[1] Would need additional scientific studies of processes governing instream nutrient transformations—travel time, tributary loads, continuous DO for productivity estimates. Need to understand big river processes like the role of autochthonous production. Need to characterize spatial and temporal variability. Existing monitoring programs are good for tracking but not diagnosing these issues. The coarse grid model of the entire Sound would provide enough information to answer Question #1 within one year of initiation of the project. Question #2 requires site-specific analysis of sensitive embayments, and this work is already underway in some areas and planned in others. The following is the estimated timeframe for providing model scenario results in these areas:

Hood Canal (UW) – May 2008
Budd Inlet (Ecology) – December 2008
South Sound (Ecology) - March 2009
Whidbey basin (Ecology) - planned
Sinclair/Dyes Inlet (Navy/Ecology) - potential extension of existing hydrodynamic model

Links to Other Puget Sound Interests

The model framework to be developed for nutrient analysis, either FVCOM or an equivalent program, will have capabilities that can directly support non-nutrient issues in the Sound. The model will have the capability to predict the following:

- impacts of near-shore structures on local currents and water quality
- spill trajectories
- bacteria fate and transport
- relative impact from specific, wide ranging sources (e.g., Victoria sewage discharge vs Seattle West Point)
- conditions favorable to fish (e.g., currents, temperature)
- toxic pollutant fate and transport

Model Specifications

It is essential that the model frameworks used in this work are open source (non-proprietary) programs, which allows Ecology and EPA to share the model with all interested parties when conducting an administrative process for a regulatory decision. The WASP and FVCOM model frameworks fit this requirement. In addition to employing non-proprietary software, it is desirable for the models to be readily accessible to Ecology and EPA (and other interested agencies/parties), and for the models to be configured such that run times for simulations are reasonable. The primary factor affecting run times is model grid resolution, and this leads to the distinction between level 2 and level 3 models. The level 2 model is a coarser grid, and this offers relatively faster run times and project efficiency for a large scale management question. For smaller scale (single embayment) assessments, a finer resolution model (i.e., a sub-model of the level 3 model of the entire Sound) can be used to analyze water quality at a smaller scale.

WASP is developed and supported by EPA's Office of Research and Development (Athens Laboratory). The WASP box model for level 1 analysis is already constructed and initially calibrated from work performed to date by Ecology and EPA.

FVCOM is developed by the University of Massachusetts. Pacific Northwest National Laboratory (PNNL) has developed an FVCOM hydrodynamic model of Puget Sound and applied the model for near-shore habitat assessment, and the FVCOM framework includes water quality sub-models. The model grid extends throughout the Sound and is currently undergoing extension to Dixon Passage in Canada. Initial evaluation of hydrodynamic simulations has been conducted. The model employs an unstructured grid, and this offers advantages in adjusting the model to handle a variety of assessment questions at different spatial scales. The plan above notes that the FVCOM "or equivalent" model framework would be employed. There are several 3-dimensional water quality model frameworks that can be applied to Puget Sound for circulation, nutrients, toxics, and bacteria. However, the unstructured grid aspect of FVCOM is distinctive and important for handling the complexity of the Puget Sound. Final model selection will require a thorough comparison of model capabilities, including nutrient kinetics.